High Frequency Radio Network Simulation Using OMNeT++

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Overview

- Developing new modems and protocols for HF radio data communications
- Many issues with HF make simulation attractive
  - But with unique issues and requirements
- Using OMNeT++ and inet framework has simplified the process
- Results will be used to drive standardization discussions and future products

HF Radio Benefits

- Skywave property allows very long distance communications without infrastructure
  - My personal best is 11,500 km
- Statistically predictable performance, but…

HF Radio Challenges

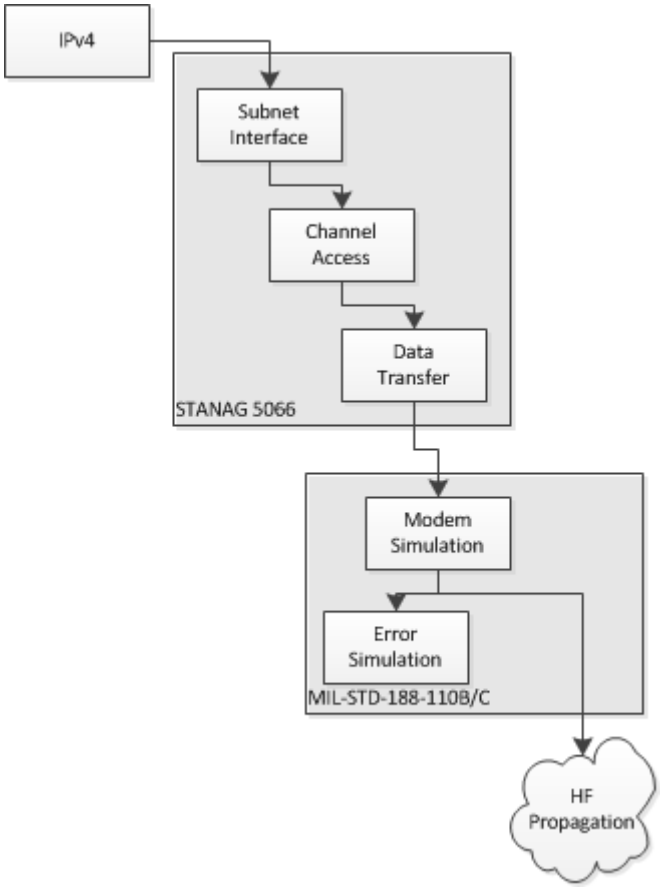
- Low data rates
  - Narrowband (3 kHz), 75-9600 bps
  - Wideband (up to 24 kHz), may reach 100 kbps
- High error rates
- “Bursty” errors
- Multi-mode fading, including long-term fades
- Interference from natural and man-made sources worldwide
- Most of the time, only a small part of the spectrum actually propagates.
  - Users are crowded together

Simulation Advantages

- Cost
  - Much lower cost
  - Much faster
    - Lower data rates + higher variability -> longer test runs under more varied conditions
  - Not unique to HF, just more
- Repeatability
- Able to instrument entire network
  - Additional insight into performance
  - Able to define and refine “what-if?” scenarios

Simulation Design

- Connected to IPv4 module
- Layered model
  - Defined by standard
- Error simulation is part of modem
  - Errors occur as modem mis-interprets received signal
- HF Propagation model simply distributes transmissions to other nodes
  - Improvements coming



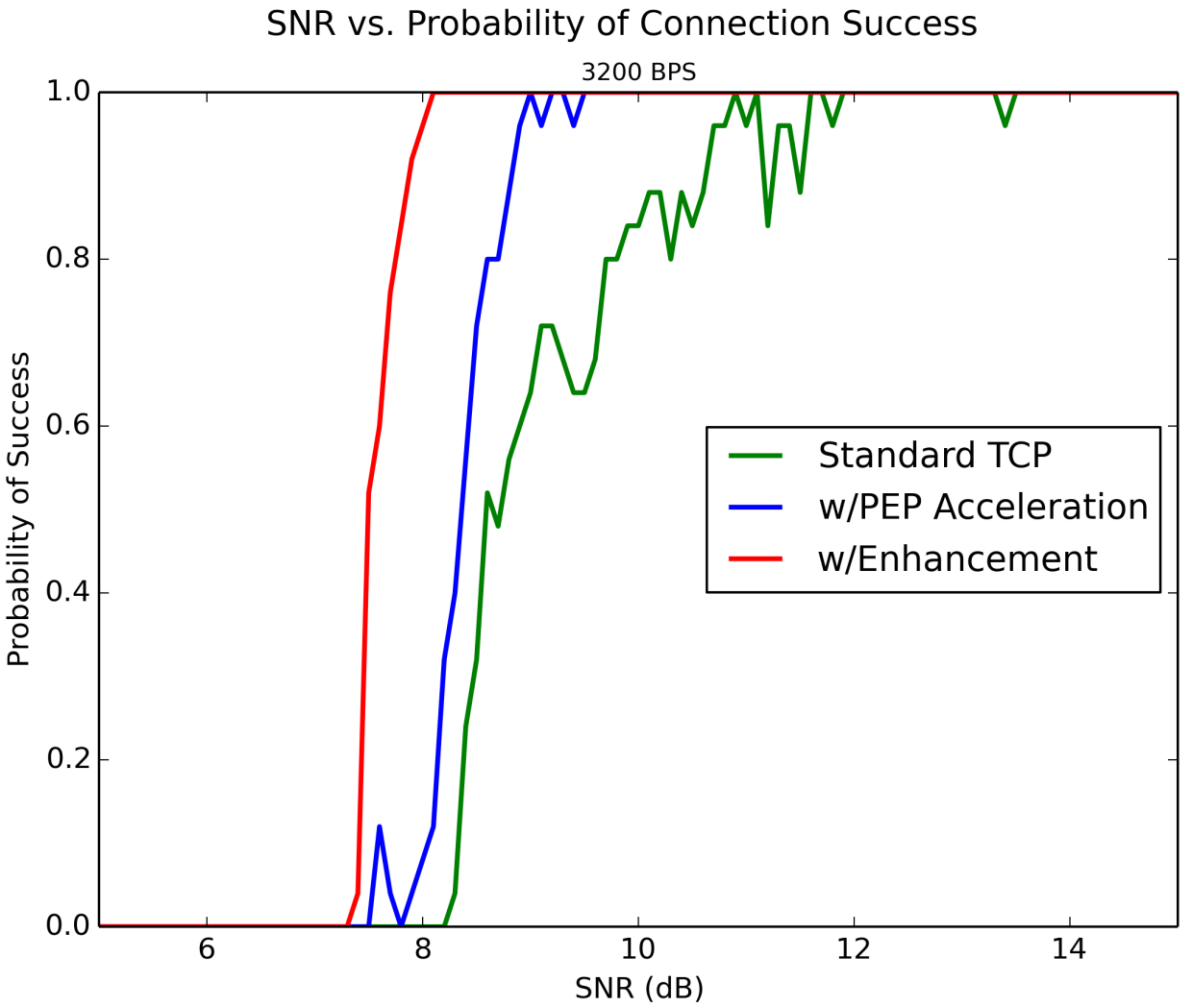
Error Model

- Accurate propagation modeling requires extensive signal processing computations
  - Too slow for simulation
- Our solution is to run that model offline
  - Gather large amount of data
    - For each SNR, standard channel condition, and set of modem settings
  - Statistically analyze each data set to determine distribution of errors
  - Develop simple statistical model to match that distribution

Error Model (cont.)

- Key concept – every run consists of alternating error-free and mixed sequences
  - Statistically model length of each sequence
  - Statistically model BER within a mixed sequence
  - As bits are processed, errors are generated in a way that simulates real-world outcomes
- Resulting bit-error pattern corresponds to actual data traces taken on air and through DSP simulators

Initial Results



Future Work

- Channel Model
  - Add per-link parameter modeling
    - Including realistic antenna/ionosphere modeling
- Modem Model
  - Add intermediate and long term SNR variations
  - Add wideband modem models
- Wideband STANAG-5066
  - Experiment with wideband protocol concepts
- Channel Access
- Advanced protocols
- Improvements to TCP processing
  - More cross-layer interactions

Finally

- Heartfelt thanks to the OMNeT++ community
- Easy to learn the basics, but plenty to learn
- Outstanding depth of capability
- Large and active user community
- “Does exactly what it says on the tin”